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PERSONAL.

BY RICHARD A. PROCTOR.

IN a letter to the publishers of KNOWLEDGE, Mr. Lockyer, under date May 11th, writes as follows:—

"My attention has to-day been called to several references to me by Mr. R. A. Proctor in recent numbers of KNOWLEDGE. Among them I find the following (April 20, 1883, p. 240):—'J. N. Lockyer.—Your unsigned post-card received.' I must request you to find space in your paper for the following statements as to matters of fact:—1. I have sent Mr. Proctor no post-card. 2. I know absolutely nothing about anyone else having done so."

I need hardly say that I most gladly find space in my paper for Mr. Lockyer's statements. I regret that he should have had occasion to make them—partly through undue haste on my part, but chiefly through the wrongdoing of a common acquaintance. I must beg him to believe that when I received from the office, on Monday evening, April 16 (that is, when the last paragraphs of KNOWLEDGE for April 20 were being made up*), a postcard vituperating me for what, it seems, Mr. Lockyer had regarded, seventeen months ago, as an offence against him, I thought more of the charge brought against myself than of the meanness of anonymous letter-writing. I wrote *then* to defend myself, not to attack him. I had made advances, not, I think, ungenerous, a year and a half ago, and I was pained to find that a slight detail in the negotiation had given new offence, at the very time when I was endeavouring, at some sacrifice, to put matters right. I had answered my friends—Professor Young, Mr. Clodd, Sir Edmund Beckett, and others—through the correspondence columns; and there could be no cause of offence—no offence certainly was intended—when, in the hurry of answering a great number of communications, I responded to a business letter of Mr. Lockyer's in that way. I was thinking of *this*, not of the offence of the anonymous letter writer, when I responded in KNOWLEDGE to a communication which, at a first view, seemed—for reasons which I then indicated—to come unquestionably from the only person who could have known personally anything about the matter referred to. Yet it should be noticed that, even in that first reply, I showed that there was that opening for doubt which subsequently led me to recognise another hand in the matter. In KNOWLEDGE for April 27th, in an article entitled "Social Dynamite," I indicated that doubt very clearly, and denounced the writing of anonymous letters, chiefly on the ground that they lead to precisely such mistakes as that into which I had fallen. I had had time to consider the meanness and cowardice of the wrong done to Mr. Lockyer and (in less degree) to myself, by the person who had endeavoured to cloak his misconduct by inserting a passage which was calculated, and doubtless intended, to suggest the idea that Mr. Lockyer had sent the card to me.

And now to the question whether the real wrong-doer can be detected. Mr. Lockyer must be interested in this even more than I am. Indeed, now that I find my first idea was erroneous, I am only interested because the person who did this thing caused me, in the hurry following the first explosion of his keg of social dynamite, to entertain and act upon an erroneous notion. The readers of KNOWLEDGE may not be for the most part interested in this matter, any more than they are personally interested in the capture of dynamite offenders; but I must ask them to forgive me for giving so much space to the subject as may help to unearth a mischief-making individual, who, if early detected, or even threatened with imminent detection, may be hereafter innocuous.

The post-card bears date April 13, which was the date of the last meeting but one of the Astronomical Society. On that day, unless I mistake, Mr. Lockyer met, near the region from which the post-card was issued, the members of the Solar Physics Committee. I note this to remind him of the time when this card was certainly written (or rather printed) and posted. He may possibly remember speaking on that day to some one of those (very few, I am happy to believe) who entertain ill-feeling towards me. It must also have been one who professes friendship towards Mr. Lockyer—but very insincerely. Among the subjects of conversation with such a one, then or a day or two before (simply because the matter would soon have been forgotten, if not quickly acted upon), must have been Mr. Lockyer's annoyance at my answering him through the correspondence column. If among those to whom, about that time, Mr. Lockyer was led to speak on that subject, he can think of one who (1) really wishes ill to me, and (2) may conceal under specious appearances a dynamitic disposition, he will not be far from the wrong-doer to whom he and I are alike indebted.

Next for myself. Can I not in some degree help the search? I think I can.

First, the taste for sending abusive post-cards is, thank goodness, an exceptional one. Among my acquaintances, do I know any one who has shown an inclination that way? I can think of only one (I omit a notorious offender in this line, who happens, oddly enough, to be mentioned on the first line of my post-card—because *he* always signs his abuse, whether calling me or Mr. Wallace bad names.) There was one who addressed a friend of mine, whom he hates bitterly (and naturally, for my friend is a very outspoken man), adding a number of titles between the name and the address *on the envelope*, with obvious intent to reflect ridicule on him and cause him annoyance. It so happens (wherefore I think I must be outspoken too) that this person honours me also with strong dislike. Strangely enough, too, I happen to know that he had met Mr. Lockyer near the time when, and not far from the place whence, this post-card was despatched.

A few other points I omit for the present.

* I lectured in Dublin on Wednesday, April 18, at 4 p.m. It will be seen how little time there was for weighing the matter.

Lastly, although the words on the post-card are printed, there are seven distinct peculiarities in the lettering, the presence of *all* of which in the known writing of the person who sent the card would serve to convict him of his offence in any court for dealing with users of social dynamite.

I fancy that if Mr. Lockyer should join with me in endeavouring to discover and expose the real offender, we might probably succeed.

PLEASANT HOURS WITH THE MICROSCOPE.

By Henry J. Slack, F.G.S., F.R.M.S.

SPRING is a good time for watching the aphides, or plant-lice, in greenhouses, and also out of doors, especially upon young shoots and buds of roses. A favourite house-plant at this season, the so-called "Marguerite," or French daisy, which is a chrysanthemum, is likely to be attacked. The aphides will be seen in crowds surrounding the flower-stems, which they seem to like better than the leaves. Looking at some of these groups with a hand-magnifier will most likely show that, besides various sizes of old and young, there are some of a dingier colour. These are the pupæ, which produce no series of budding young ones, but allow a single winged female to come out, as a butterfly does from its inactive chrysalis. As it is well, while writing about any such matters, to have the objects under view, and to observe their processes of change, several pupæ were placed in little cells, as described in the last paper, and watched frequently; but, as it turned out, not continuously enough for success, as one of the creatures produced its imago, with four delicate wings, when no one was looking, and the skin from which it emerged soon shrivelled up. It is well worth while to see how the imago gets out by a slit in the back of the pupa. The pupa goes on feeding like the larva, up to its time of change. Then a rent begins behind the eyes, which proceeds down the thorax, through which the brown head of the imago emerges. The antennæ and legs are slowly pushed forward from the exuviæ, or sheath, which slips down the soft body of the fly by a kind of peristaltic motion, "very interesting to watch under the microscope." So says Mr. Buckton, and many readers of Knowledge may take the trouble to witness what he describes. The wings grow rapidly—so much so, that he found it difficult to keep pace with them in working a drawing. Winged females look so different from the larvæ and pupæ that they would be taken for different kinds of insects if their origin were not known. The front wings are large in proportion to the size of the little creatures, and beautifully tinted with prismatic colours. The occurrence of winged viviparous females allows fresh colonies to be established wherever they settle. The larval aphides are poor travellers, and the majority live and suck their lives through close to the spot of their birth. It may be well imagined that the juices of a plant are changed in character wherever a swarm of aphides have inserted their piercing and sucking tools. An entire plant soon sickens if not relieved or protected against their ravages. It is supposed that to facilitate a flow of the plant's juices they pour in a poisonous fluid, as gnats do into our bodies, and, as the character of the food is changed by the injury they do to the plant, it may become less favourable to the production of young by the budding process, and more so to the production of the pupal forms. Temperature has also something to do with the matter, but Mr. Buckton thinks the main cause is the necessity of seeking food in fresh places. At first only a few winged aphides are seen, but later in the season large swarms are carried by the winds to considerable distances.

Rose-twigs are now (April 30) liable to such strong attacks of these creatures that they may be examined with a good chance of finding larvæ and pupæ in various stages. The latter are orange-coloured, and easily distinguished from their bright green companions. In all the pupæ the wings of the future insect are seen in little projections, like the flappers of a seal. The eggs of the rose aphis are little black things, stuck into a crevice in the bark, or near a bud in the winter. They hatch out in the spring, and can withstand a considerable degree of cold. Mr. Buckton mentions an instance in March, 1873, when the young aphides appeared, and survived, although the thermometer marked 25° F. As early as the seventh hour of their age he has noticed rudiments of the future young in the body of the parent.

Aphides of all kinds increase most quickly in a sheltered situation. In greenhouses they do not like free currents of air, and out-of-doors they will attack roses in verandahs on the south side of a house before any seen in the open windows. Most of the nostrums advertised as killing-cures of these and other plant-plagues are of no use whatever. The Gishurst Compound (a sulphur soap) is really disliked by many, and it is well to wash the bark of trees attacked by any of the aphis, or bug, tribe with it, or with a mixture of quicklime and sulphur boiled in water. A teaspoonful or two of each in fine powder to about a quart of water can be cooked in an earthen pipkin. The mixture should be stirred up for use upon trees, and the clear yellow fluid only employed where a stain would be inadmissible. Lime and size are often used against the cotton bugs, but it is the size that really kills them. Finely-powdered sulphur, or snuff, is useful when the creatures cannot be washed or brushed off; but I find Hardiman's Powder, sold in little tin boxes with a bellows arrangement, the best I have tried. The stuff looks just like Keating's well-known Insect Powder, which is said to be made of a species of *artemisia*, but it is finer. Like Keating's, its little fibres stick to insects' hairs, or any roughness, and although it gives off no appreciable odour to our noses, it probably exhales something injurious to insects, that die, sometimes rather quickly, sometimes after an hour or two, but are instantly injured by it.

THE BUYING POWER OF GOLD.*

VARIOUS comments have been made by able critics on the views which I have lately put forward with regard to the increased purchasing power of gold. May I be allowed to submit some further considerations to the public on this important subject?

My arguments may be briefly condensed as follows:—

Gold to the amount of nearly £200,000,000 has been required for supplying Germany, the United States, and Italy with new gold currencies.

This extraordinary demand fell on a diminished supply. The annual production of gold during the first five years after the discoveries of 1851 averaged nearly £30,000,000. It now amounts to less than £20,000,000. The new demand has been equal to the total supply of ten years. At the same we have to reckon with the normal demand

* From a letter to the *Times*.

for arts and manufactures, while more gold has also been required to meet the wants of an increasing population and an increased balance of transactions in all gold-using countries.

No evidence is before us to prove that a fresh development of banking expedients has to such an extent further economised the use of gold as to neutralise this normal rate of increase. On the contrary, it is believed that in England alone the gold circulation has grown by £20,000,000 in ten years.

It is a received axiom that prices of commodities are affected by changes in the volume of the circulating medium in which they are expressed. The late strain on the common stock of gold must, therefore, have had some result. It must have caused a general decline. Examined by the test of present prices, these deductions are borne out by facts. A general fall has occurred, though exceptional circumstances have maintained the prices of some articles and accelerated the fall of others far beyond the average.

But this general decline is not in itself a calamity. The period of transition from a higher to a lower set of prices is likely to be accompanied by much real suffering and more apparent suffering. But when the change has been accomplished, commerce and manufactures may prosper as before. The final disturbance will be limited to those cases where individuals or corporations have permanent contracts either to receive or to pay fixed sums of gold, and to those further cases where exceptional circumstances of habit, convenience, or sentiment will probably come into play.

Such is my argument. In its main lines it seems to be unassailable, though I may have failed in some of my illustrations, and have dwelt too little on qualifying circumstances. If my position is to be attacked, it must be shown either that I am wrong as to the existence of the cause which I allege, or that the results which I maintain to have followed cannot be traced, or that my description of the facts as to gold and as to low prices may both be correct, but that it cannot be proved that the former have led to the latter; or, lastly, the general argument may be admitted, but its particular applications be disputed.

No serious contentions have been put forward that I am wrong as to the strain upon gold. My allegations as to prices have been more seriously questioned. To those who deny a fall in prices altogether, I would only say that, even if they were right, the extraordinary demand for gold cannot have been without a result. On this hypothesis it must at least have had an effect in restraining a rise. If it is contended that prices are not low, as I contend they are, it must in any case be admitted that they would have been higher if the circulating medium in which they are expressed had not been called upon to perform largely increased work without a proportionate increase in the supply. It is impossible to assert such a cause to have had no effect.

I am bound to say that I am myself astonished to see in the case of how many articles prices have gone back to the rates which prevailed before the gold discoveries of 1850. I was scarcely prepared to find that, taking an average of the most important articles of consumption, almost the whole of the advance in prices consequent on the immense increase in the supply of gold thirty years ago has been lost. Even should this not be so to the full extent, I think it will be admitted that I have at least furnished substantial additional proof that prices are at present ranging on a very low level.

But very natural remonstrances have been made to me. "It is all very well to speak of low prices in statistical tables; but is it true that prices have so far fallen to the individual purchaser and to the spender of money as to establish the proposition that a sovereign goes further?" This question is so interesting and important that I should like to examine it more fully in a future letter. At present, I will confine myself to pointing out that, especially in the expenditure of the upper and middle classes, the purchase of commodities forms by no means the largest part; on the other side are house-rent, rates and taxes, wages, travelling, children's education, and numerous other items for what I may call "services rendered," and it can easily be shown why the prices paid for "services rendered" do not fluctuate with the same rapidity as market prices. In many cases tradition, or a professional code, or an actual law has fixed an immutable scale. However the purchasing power of gold may fluctuate, the physician, the singing master, the dentist receives the traditional guinea, the lawyer his 6s. 8d., the cabman his legal 6d. per mile.

But the chief item of "services rendered," and one requiring the fullest examination, is the question of wages generally. The question would form part of any further disquisition on the purchasing power of gold as regards "services" as distinguished from commodities generally.

I now turn to the objections made, not to my contention as to low prices, but as to their resulting from the particular cause which I have discussed. Granting, it is asked, that prices are exceedingly low, can you prove that facts connected with gold are the determining cause?

Some writers have appeared to show something approaching to irritation at the view that the situation of gold should have largely influenced prices. I scarcely know why, unless through the apprehension that the bi-metallists may utilise the argument. I must repeat that to my mind the connection between the additional demand for gold and the position of prices seems as sound in principle as I believe it to be sustained by facts. On the other hand, I cannot plead guilty to the charge which has been made that I have overlooked or denied the existence of other causes. I enumerated as possible contributory causes, the increased facilities of communication, the operation of the telegraph, the progressive elimination of the profits of middle-men in international commerce, decreased speculation, and increased production. At the same time, it is clear that many of these causes were almost as fully developed during the period 1870-75 as during the years 1875-83. They must have contributed over a course of years to cheapen the cost of many commodities, but to my mind they do not account alone for the prices of the last five years. Bad harvests in England have, no doubt, also operated to a considerable extent; but it is not in England alone that the fall in commodities has taken place. Nor has the average of prices risen with the better harvests of the last two years.

With regard to the deductions to be drawn from my general argument as to the probable effects on commerce and manufactures of a lower level of prices generally, it is, I think, a matter of the highest moment to the manufacturing community to consider whether the present range of prices is still the result of what is called "depression," of absence of prosperity, of slackened demand, and so forth; or whether we have to deal with the circumstance that prices are affected by a change in the purchasing power of gold. If the latter view is correct, the sooner men make up their minds to it the better. They will then cease to base their operations or found their hopes on the return to a scale of prices which would, under existing circumstances, represent even higher prices than before. So long as men think that the low price that an article may command simply means bad

business, so long we shall hear of the decline and sickness of our commerce, though the volume of our exports and imports may be quite satisfactory. It is surely important that men's minds should be clear in this respect.

As I have repeatedly stated, it would be most unwise to dogmatise or to prophesy where the operation of causes is so covered and obscured by countless modifying circumstances, but it is none the less right to trace them and bring them into light as far as it is possible.

George J. Goschen.

ON A TOY TRICYCLE.

By John Browning,

Chairman and Treasurer of the London Tricycle Club.

I TRUST the readers of Knowledge will not suppose from the heading of this article that I am about to inflict on them a description of one of the children's tricycles which are to be seen standing outside toyshops. Yet these toys are remarkable in their way: they contain nearly every fault which can be included in such a limited compass, such as bad workmanship and materials, weakness where strength is required, and weight and strength where they are unnecessary.

But it is still more remarkable to see what a plucky boy or girl can accomplish on one of these compounds of mechanical blunders, actually mounting inclines which would tax a moderately good tricyclist on a fairly good machine.

I have, however, to tell of a tricycle of quite another kind; one in which the workmanship almost equals that of a good philosophical instrument, and the materials are of the very best, being of steel nickelised and gun-metal, and in which it would be difficult to reduce the weight of any part by a single ounce without unduly weakening the machine; and yet this tricycle was spoken of by those who ought to have known better as a toy!

The circumstances which led up to this machine being built will, I think, prove interesting to all who care for the history of the tricycle and desire its further improvement.

Soon after Starley invented the Lever Coventry Tricycle, I called at the London warehouse of the manufacturers and asked for as light a machine as they could make me. They showed me some machines, the driving-wheels of which were 54 inches in diameter, and the weight not, I have reason to believe, less than from 115 lb. to 120 lb. They told me the machine could not be made to weigh less. I suggested that if they would make the driving-wheel 45 inches, the whole machine might be made smaller in proportion and to weigh considerably less. They assured me that a smaller wheel would not pass over the obstacles often met with on ordinary roads, that the speed of the machine would be greatly reduced, and that the machines with the largest wheels went the easiest up hills! I told them that this was against all the principles of mechanics. The reply I received was that they did not care about the principles of mechanics; they had tried the experiment of riding up hills, both on small and large wheels, and they were quoting practical results.

As I was then unknown in the tricycling world, I could not persuade them to do anything for me different to their stock machines. An agent with whom I had some influence got the same firm soon after to make me a machine with a 50-in. driving-wheel. The weight of this machine—which, it must be recollected, had only one large wheel—was 97 lb. The standard dimensions of these makers are now machines with driving-wheel 48 inches diameter, weighing not much more than 75 lb.

At the commencement of the next season I saw Starley, who then showed me his new machine, which he had christened the "Salvo-quadricycle," the same excellent, all-round machine which is now known as the "Salvo." This machine weighed about 112 lb. I admired the ingenuity of his now universally-adopted double-driving arrangement, and told him that the machine was very suitable for a man weighing from 16 to 18 stone. I added, that if he would make such a machine to weigh 56 lb., it would suit me exactly. He said he could not reduce the weight, and I declined to have one. This machine had 50-in. driving-wheels. The next season he brought out a lady's "Salvo," with driving-wheels 46 inches in diameter, and said to be much lighter. One of these machines I bought, and it proved to weigh 96 lb. The wheels were geared down to 38 inches, and my pace was faster on it than on the Lever and Coventry by about twenty per cent., at least.

Since then I have ridden sometimes as many as four or five machines in a single day, through the kindness of members of my club, and I have generally owned several tricycles myself varying greatly in construction.

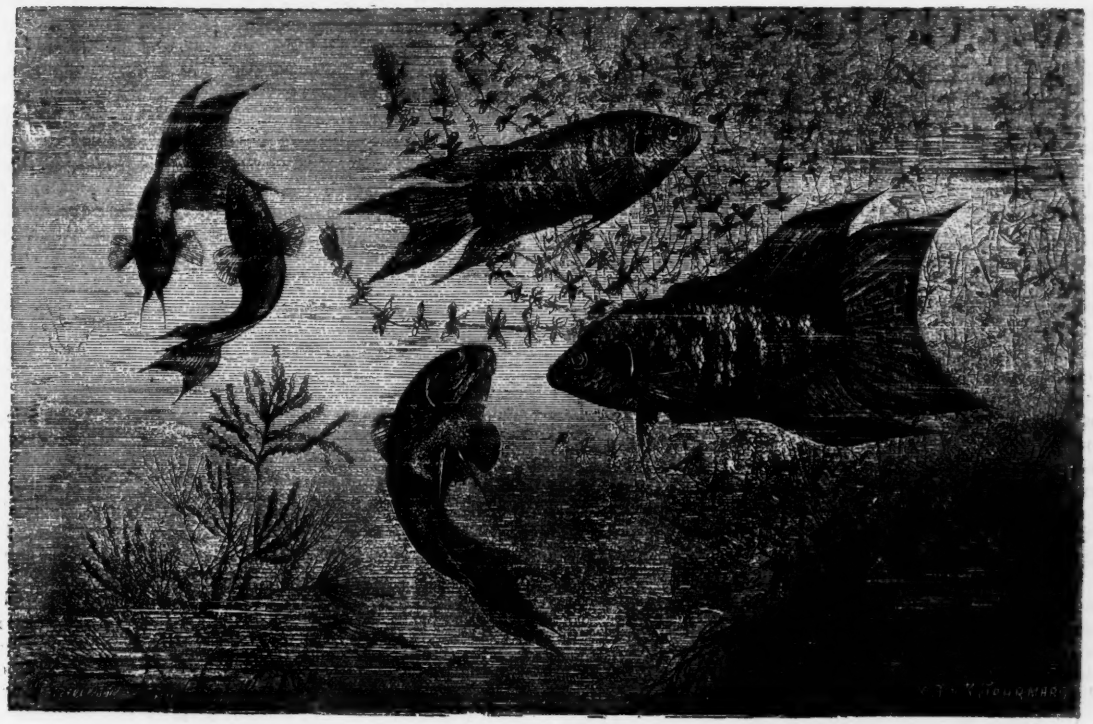
As a result of my experience, I prefer a rear-steerer, with ratchets for easy riding or touring, particularly when carrying luggage or photographic apparatus, *provided the machine be so made as to be safe when running down hill.*

I have always advocated riding at about the rate of six miles an hour, using but little, if any, more exertion than would be necessary to walk at half that pace. At this speed any person, with a little practice, can ride from 35 to 50 miles in a day without fatigue. But at the end of last season I determined to have one machine on which I could travel at the highest rate of speed I could well attain. To do this, I knew that, being light, and not physically strong, I must get the lightest machine possible. On considering the whole of the machines known to me, I found that Humber, Marriott, & Cooper had reduced the size of the driving-wheels of their Humber Tricycle to 42 inches, and the weight to about 65 lb.

I asked them to make me a machine with 38-in. driving-wheels, and to keep every part of the machine down to the lightest possible weight. This troublesome commission they readily undertook, and carried out. The machine was completed and exhibited at the Albert Hall in February last. The weight proved to be 52¼ lb.—only a few pounds more than the weight of a roadster bicycle. Because of its small size, it was spoken of as the "Toy;" but I am now able to state with confidence that it does not merit that name. I have ridden it through 300 miles of exceptionally hilly country, over many rough roads; and although the 38-in. wheels are geared to run as 50 in., I have ridden up every hill on it that I could ride on other machines geared down to 40 in., and my pace is at least one mile per hour faster than on any machine I have previously ridden.

When I can get one of the new two-speed gearings adapted to this machine, so that it can be made to run for hill riding at about 35 in., and for the level and down-hill at about 55 in., it will be for fast riding all I can desire.

Candour compels me to add that it requires most careful handling, particularly when riding at night-time. But those who are not nervous, and who will take time to learn to ride this class of machine, will find themselves well rewarded for their pains.



THE PARADISE FISH.

THE paradise fish is a representative of the family *Macropus*. These fish have very large fins, less developed in the female. The brownish colour of the upper side changes into a greenish gray on the lower side; the markings consist of changeable yellowish green, or blue and red cross-lines. Their length is from eight to nine centimètres.

Very little is known of these fish in their free life. They are universally kept in activity in China, and treated as our gold fish, but are more easily propagated in a limited space.

They are better adapted for household pets than other fish of this class, as they can live in a much less quantity of water, and can remain out of the water for twenty minutes and more without injury. Giraud brought one hundred of these fish from China, and, although during the tedious journey he was not able to give them sufficient room or the necessary care and nourishment, twenty-two of them lived.

Benecke says that "in May of the year 1878 he obtained a pair of paradise fish. They were placed in a basin containing about forty litres of waters. They immediately went to work to devour the small crawfish and larvæ of insects which had been placed in the vessel. After these were consumed two crawfish, water fleas, and mussels were put in. The mussels they had not received before, and evidently had never eaten them, for at first they only took hold of the little animals and then released them with a shake of the head, but after a day or two they only ate the mussels, leaving the water fleas placed in the basin unmolested. One day no mussels could be obtained, and they ate greedily not only small but very large angle worms, from five to eight centimètres long and two millimètres thick. They always rejected the intestines of the worms. When the worms were put in the basin, as they were taken from the ground, they would shake them two or three times, then let them go, then throw them around in the water, in order to shake off the dirt before eating them. If the worm struggled, they would sling it against the water plants or the sides of the basin.

About three weeks after the fishes were received the male began to build a nest. For this purpose he would come up to the surface of the water, take his mouth full of air, thrust it under the water, forming small bubbles of film like spittle, and continue thus to build a layer of these bubbles hanging quite firmly together, adding new layers until it was completed.

About twenty-four hours after the spawning, the germ may be perceived in the pale yellow yolk of the egg—a day later the heart begins to beat—twelve or eighteen hours after the young, imperfect fish escapes from the egg; it is similar to a small tadpole. In eight months it is full grown. So long as the fish needs parental care the male devotes himself to it. As soon as the young fish starts away he hastens after it, seizes it with his mouth, swallows it, and spits it out into the nest of foam. They care specially for the sick and feeble ones. As soon as the young fish no longer needs his assistance he forsakes it, without appearing to have any interest in its fate, and has no hesitation in devouring it.

The young subsist at first upon the foam of the nest, later upon small animalcules not visible to the naked eye, and finally upon the same food as the parents.—*From Brehm's Thierleben.*

ON THE FORMATION OF COMETS' TAILS.

By A. C. Ranyard.

If the repulsive force which drives the matter of a comet's tail away from the sun is due to evaporation of the substance of meteoric particles, there must be in space meteoric matter of a kind which does not reach the earth's surface. By far the largest number of the meteoric bodies which have been seen to fall belong to the class of stony meteorites. I make a distinction between the meteoric masses which have been picked up immediately after their fall and the stones and masses of iron collected in museums to which a meteoric origin is attributed, because, owing to differences of hardness and to differences in their chemical constitution, some meteoric masses withstand the weathering effects of air and water better than others; and we should therefore expect to find a larger proportion of the harder and better weathering meteorites in museums than amongst the known falls. Iron meteorites are also more easily recognised as of meteoric origin by an ordinary observer than stony meteorites, and consequently an undue proportion of such iron meteorites ultimately find their way to museums.

One must not, therefore, go to the catalogues of meteoric bodies collected in the museums of Europe and America to determine the proportion of the different kinds of meteorites existing in space. We shall probably obtain a truer idea of the kind of matter which circulates in the parts of space swept by the earth, if we confine our attention to a smaller number of meteoric bodies whose fall has been observed, Of these, according to the estimate of Dr. Flight, about 90 per cent. are stony meteorites; the remaining 10 per cent. belong chiefly to the nickel iron class, and there are only a very few bodies composed of amorphous carbon and bituminous matter, such as the Kold Bokkeveld, Orgueil, and Alais falls.

Without pretending to say what would be the temperature on the sun-illuminated side of a dark body in space at the earth's distance from the sun, we may be sure that the heat derived from solar radiation would not be sufficient to raise such a body to a temperature of white incandescence, for the moon (which certainly is not enveloped by an atmosphere of a thousandth part the density of the earth's atmosphere) appears nearly black when it passes into the earth's shadow during a lunar eclipse. The slightly ruddy tint which the moon's disc presents under such circumstances cannot even be due to a cherry-red temperature of the lunar surface, for if this were the case, the ruddy tint would be most visible in the region of the lunar equator, where the sun's rays had been falling nearly vertically; but the red light is more or less evenly diffused over the whole lunar disc, and differs considerably from one eclipse to another, showing that it is due to light which has passed through the earth's atmosphere, and has reached the moon after absorption within the zone around the earth, which an observer on the moon would see under such circumstances as a line of red light fringing the dark disc of the earth, interrupted here and there by clouds and haze in the lower air.

I will not digress to give an account of the Earl of Rosse's observations as to the temperature of the lunar surface, or of other considerations which may be urged to show that the temperature of the sun-illuminated side of a dark body not surrounded by an atmosphere, and situated at the earth's distance from the sun, lays somewhere between 300° and 500° Fahr. For my present purpose, it will be sufficient if we take it as proved that a dark body would not be raised by such direct radiation to a temperature of white incandescence. No doubt, all bodies are volatilisable if exposed to a sufficiently high temperature; but I know of no meteorite, whether of the Kold Bokkeveld, or of the iron or stony class, which could be driven into vapour by temperatures that would not suffice to make the body glow with a white heat.

Comets frequently develop tails at distances from the sun considerably greater than the earth's distance. The great comet of 1729, when in perihelion, was more than four times the earth's mean distance from the sun, and it showed during a period of more than five months an extensive nebulosity, though the heat due to solar radiation must have been less than one-sixteenth the heat derived from solar radiation at the earth's distance.

Mr. A. S. Davis, and those who think with him that the repulsive force which drives the matter of a comet's tail away from the sun, is due to evaporation of the solid matter of meteoric bodies, may reply by suggesting that possibly blocks of ice travel in space with the meteoric bodies that reach the earth's surface, and that the ice-blocks are evaporated by the heat developed in passing through the earth's atmosphere. There are some theorists who have even suggested that hail comes from outer space. To the advocates of the meteoric origin of hail, I would reply that if a storm of hailstones came into the earth's atmosphere with a velocity comparable with the planetary velocities with which meteoric bodies usually encounter the earth, the whole sky would be illuminated with a dazzling brightness which it is difficult to give an idea of. A single meteor, which enters the earth's atmosphere to a depth of nine or ten miles above the sea level, and, much more, a meteor which reaches the earth's surface, attracts the attention of observers for miles round, even when the fall occurs during bright sunshine; and a million such meteors, entering the atmosphere at once, would, by their light and sound, dazzle, as well as deafen, the most unobserving of men.

It is usually difficult to drive from his hobby the thorough-going theoriser, who is always ready with a new supposition, which he does not condescend to found on observed facts; and the meteoric hail-men reply that it is not necessary that the earth should meet the showers of meteoric hail. The hailstones in space may all be travelling in the same direction as the earth round the sun, and with but slightly greater velocity, so that they may come up quietly from behind, and pass through the earth's atmosphere at any rate you please. I would remind them that the earth's attraction is sufficient to give a velocity of seven miles a second to a body which starts from rest at an infinite distance, and though it is possible to conceive of a single meteor falling with a less velocity, showers of meteoric hail, catching up the earth from behind, must enter the earth's atmosphere with a velocity of at least seven miles a second.

Sir William Thomson has shown that a thermometer, placed in front of a body which moves through the atmosphere at the rate of 125 feet per second, rises one degree; with higher velocities the increase of temperatures is proportional to the square of the velocity, being four degrees for a velocity of 250 feet, sixteen degrees for a velocity of 500 feet, and so on. Consequently, a velocity of seven miles a second would be sufficient to cause a rise of temperature of more than eighty-five thousand degrees, which would be more than sufficient to drive iron and platinum into vapour, and would cause the moving body to glow with a brilliant white incandescence.

Mr. Davis, who, I assume, does not advocate the theory of meteoric hail, may say that the heat developed in passing

through the earth's atmosphere would melt his cubic mètre blocks of ice, but I cannot permit him to retire under cover of such a plea. The November meteors enter the earth's atmosphere with a velocity of about 44 miles a second, so that if we assume incandescence to commence at a height of 120 miles, a meteor of the November shower entering the earth's atmosphere perpendicularly, would, if its motion were not retarded by the atmosphere, occupy only about three seconds in reaching the earth's surface; but, taking into account the diminished velocity due to the resistance of the earth's atmosphere, a meteor must fall very obliquely if it occupies more than a minute after the first instant of incandescence in reaching the earth's surface. With an ice-block, heat would be conducted to the interior more slowly than in the case of an iron meteorite; and with temperatures such as we are considering, the ice-block would probably lose a thinner skin in passing through the earth's atmosphere than an iron meteorite of the same dimensions.

The experiments of Professor Graham and the more recent and fuller investigations of Professor Wright show that all classes of meteoric bodies hold gas as a sponge holds water. Whether meteors pick up these occluded gases in distant regions of space and disgorge their contents at the sun when in perihelion is a speculation I will leave to Sir W. Siemens. But laboratory experiments show that the application of heat to meteoric bodies causes an outflow of occluded gas. In space, the gas must pass away from the meteoric masses and be chiefly projected towards the sun with velocities which can be calculated as accurately, when the kind of gas evaporated and the temperature of evaporation is known, as the velocities with which the meteoric nuclei are moving can be determined. We are not leaving terrestrial analogies when we suppose that a mist forms by the condensation of the less volatile gases at a distance from the nucleus where radiation into space can take place freely in all directions. The particles of mist will have a velocity away from the nucleus, and they will also be bombarded on the side towards the nucleus by the swiftly-moving molecules of the more volatile gases. Condensation on the surface of the mist particles and evaporation from their sunward sides will be set up and repulsion from both the nucleus and sun will follow.

The largest outflow of gas will be on the sunward side of the cometary nucleus, and repulsion from the sun will there act in a nearly contrary direction to the repulsion from the nucleus. The mist will rise from the nucleus until brought to rest by the solar repulsion*, and the mist particles will then move under the resultant force with a tendency, as I have shown, to aggregation on a hyperbolic sheet which has the sun for one focus and the nucleus for the other. If Mr. Davis's theory as to the evaporation of the substance of his meteoric ice blocks were true, there would be a great loss of substance while the evaporating masses hung balanced in the coma, and the ultimate velocity of repulsion would consequently be less than he has calculated, but the mist particles will continually pick up fresh matter, and evaporate it again towards the sun.

If the light of a comet's tail was dispersed by particles driven backwards by evaporation of their own substance, we should expect the light from the tail to be most completely polarised towards the fainter end away from the nucleus; for the light dispersed by small particles is only completely polarised when the dispersed light is viewed at right angles to the direction of illumination, and when the diameters of the particles dispersing the light are small compared with the wave length of light. Viewed from all other positions, the intensity of the polarisation varies with the magnitude of the light dispersing dust. But no increase of polarisation towards the end of the tails of comets has, as far as I am aware, ever been detected. The polariscopic evidence, therefore, does not point to a gradual decrease in the diameters of the particles dispersing the light towards the fainter end of the tail.

* Professor G. P. Bond, in the volume in which he discusses the observations of the great comet of 1858, published as Vol. III. of the "Annals of Harvard College Observatory," gives tables showing the gradual rise of successive envelopes from the nucleus, and he shows that there is a tendency to a diminished rate of ascent as the distance from the nucleus increases. The rate of ascent of the vertex of the envelopes between Sept. 20 and Oct. 20, 1858, varied, according to the estimate of several observers, from 800 to 1,500 miles a day. Professor Bond thought that he had good evidence derived from certain dark spots upon the envelopes to prove that the material of which they were composed remained in the vicinity of the nucleus for several days, and was ultimately driven off from the cusps on either side of the nucleus (see p. 356 of the volume above referred to). The great velocity with which the matter of the tail is driven away may be gathered from the rate with which new tails are formed in a different direction as the nucleus sweeps round the sun at perihelion.—A. C. R.

THE RED SPOT ON JUPITER.

AT the first regular meeting of the American Astronomical Society, held in the directors' room in the Brooklyn Academy of Music, on March 5, the topic for discussion was the "Physical Changes in Jupiter." A paper on the "Red Spot on Jupiter" was expected from Mr. S. V. White, the president of the society, and there was considerable disappointment over his inability to be present.

The remarks of the members were confined to the recent changes in Jupiter. Messrs. Parkhurst and Serviss described their observations of the great red spot which made its appearance on Jupiter's disk in the summer of 1878, and which within a few weeks has almost entirely disappeared. Others took part in the discussion.

The general opinion expressed was that Jupiter is a world which is yet in a very early stage of its geological history, and that in the great red spot, and in some other remarkable spots which have made their appearance upon its surface, evidences are seen that the planet either has already a solid or liquid surface, or that the formation of such a surface has begun. Several theories to account for the great red spot, which was upwards of 30,000 miles long by 6,000 or 8,000 miles wide, were suggested.

One theory was that some volcanic action may have been taking place, which threw up into the atmosphere a mass of smoke and erupted materials which formed the red spot. Another theory was that the crust of the planet where the spot appeared may have been exceptionally heated, so that the atmosphere above it was kept free from clouds. A third theory regarded the red spot as possibly a solidified mass thrust up through its gaseous and liquid surroundings, and forming, perhaps, the nucleus of one of the future continents of the giant planet. The difference between the rates of rotation of the red spot and of the white spot in the southern belt was referred to. The red spot overtakes the white spot once in thirty-four days.

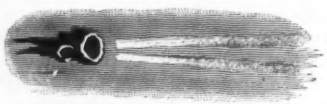
The society meets on the first Monday in April in the physical laboratory of the Packer Institute. At that time special papers will be read upon the connection between sun spots and terrestrial meteorology.—*Scientific American.*

DURING the past year there were 532 servants of our railway companies or contractors reported as having been killed and 2,423 injured, in addition to those concerned in accidents to passenger trains.

THE MOON IN A THREE-INCH TELESCOPE.

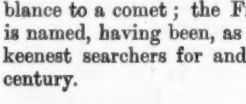
By a Fellow of the Royal Astronomical Society.

OUR first essay in the examination of the lunar surface (p. 265) was supposed to be made when the moon was between three and four days old. To-night we will imagine that her age has increased, and is about six days. The first thing which will strike the attentive student is the changed aspect, under the more vertical light of the sun, of the formations he has observed at an earlier date in the lunation. Objects near the moon's western limb, which, lit laterally by the rising sun, cast black shadows, and so revealed their configurations distinctly, are now illuminated (like the "depths of the sea," in the famous prize poem) by "the sun's perpendicular rays," and are converted into mere bright blotches upon a darker background. A strange formation, which was close to the terminator at the epoch of our last observation, so curiously illustrates the change of aspect induced by varying illumination, that we give three illustrations of it as seen in the waxing, full, and waning moon at the ages given under the respective drawings. It is numbered 327 in our Map, on

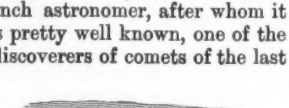


Messier. Moon's Age, 17·8 days.

p. 223, and is called Messier, presumably from its resemblance to a comet; the French astronomer, after whom it is named, having been, as is pretty well known, one of the keenest searchers for and discoverers of comets of the last century.



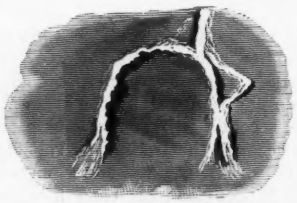
Messier. Moon's Age, 3·95 days.



Messier. Full Moon.

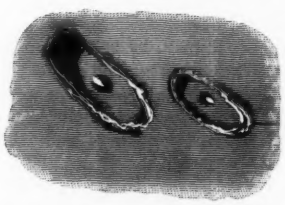
The two slightly diverging streaks which seem to radiate from the right hand, or eastern, of the two craters ("Messier A"), appear almost artificial in their regularity. The most curious thing, however, in connection with these two craters is this: that Mädler, as the result of a large number of observations, called pointed attention to their precise similarity in size, form, depth, and brightness. A glance at either of our drawings made at the telescope at the epochs specified will suffice to show that they now differ widely in this respect: that Messier itself (the western one) is decidedly smaller than Messier A, and that their major axes lie approximately at right angles to each other. The young observer should try to view this formation under the same illumination as we ourselves did in making the third of the above sketches; the long peaked shadows revealing curiously the structure of the crater walls which cast them. Messier itself is about nine miles in diameter. The southern extremity of the Sea of Nectar (V) terminates in a kind of bay, known as Fracastorius (372).

Under this illumination Fracastorius looks like what we have called above a bay. If, however, it be observed when quite close to the terminator (preferably in the waning moon), it will be seen as a complete circle, the northern part of it consisting of low detached blocks. South of it is a very fine object, the grand ring-plain Piccolomini (371), about 57½ miles in diameter. Between this and Fracastorius the moon is very mountainous. South of Piccolomini lie a number of craters and ring-plains, whose



Fracastorius. Moon's Age 5·65 days.

names may be learned from our map. Starting now from the north side of the Sea of Nectar we find an interesting pair of craters, Isidore and Capella (323 and 324); and crossing the Sea of Tranquillity from south to north we arrive at a group of craters, Römer (52), Littrow (55), Maraldi (56), and Vitruvius (57). A little range of mountains of the ordinary terrestrial type, called Mount Argæus (58), will be noted just on the Sea of Tranquillity. On the north-west boundary of the Sea of Serenity (H) lies one of the largest ring-plains in the moon, Posidonius (54), some 62 miles in diameter. There is a fine central crater in this formation, and it would form an instructive exercise for the incipient selenographer who can draw, to try and sketch some of the details which abound in this fine object. Atlas (28) and Hercules (29) here drawn



Atlas and Hercules. Moon's Age, 5·65 days.

are two noble walled plains or depressions, 55 miles and 46 miles broad respectively. It will be noted that while the most conspicuous object in the interior of Atlas is a mountain, in Hercules it is a crater. Glancing at Pliny (61), a fine terraced ring, full of little hills, on our way southward again, we will conclude our night's work by the examination of that noble triple group, Theophilus, Cyrillus, and Catherine (319, 320, 321). The study of the connection between these grand objects and of the way in which they are connected supplies us with a key to the chronology

Catherine, Cyrillus, and Theophilus. Moon's Age, 5·65 days.

of this part of the lunar surface. The valley connecting Catherine and Cyrillus will be observed, as also the way

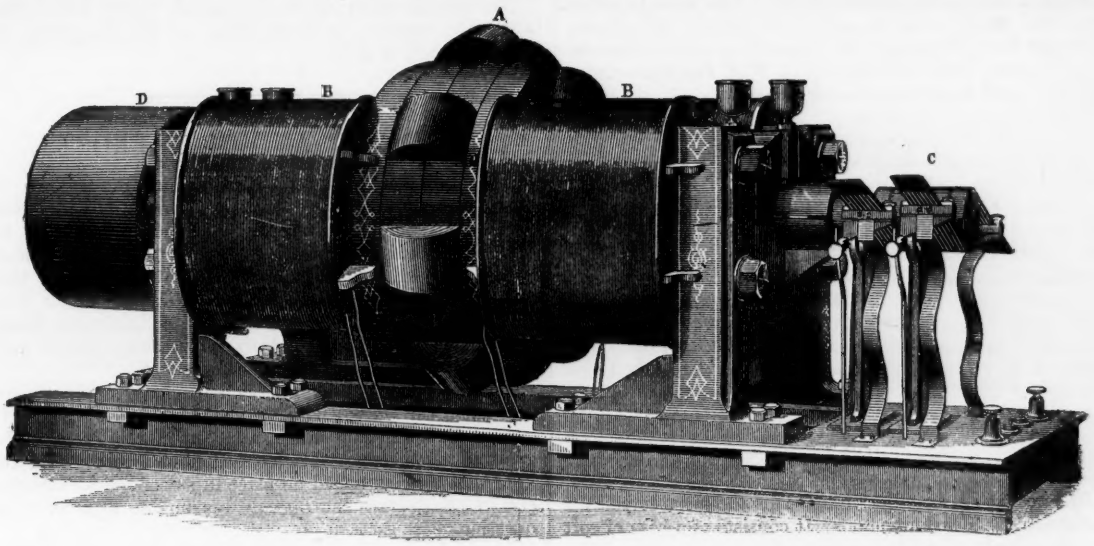


Fig. 1.

in which the wall of Cyrillus has been intruded on by Theophilus.

Little or no detail is observable in Catherine when so near the terminator, but the shape of the shadows cast into its interior reveals that of the ridges and peaks causing them. Cyrillus will be seen to be more trapezoidal than circular, and the two mountains in its centre and the conspicuous crater on its wall will at once arrest the eye. Theophilus is the deepest crater in the moon, the walls being in places 18,000 feet above the level of the bottom. Its diameter is nearly 64 miles. Necessarily its sides are brilliantly illuminated by the rising sun when the interior is plunged in the blackest night, and at about the fifth day of the moon's age it may be seen projecting beyond the terminator into the darkness of the seemingly surrounding sky as a brilliant ring. Sharp-sighted people can detect this without any optical aid.

THE BRUSH DYNAMO-ELECTRIC MACHINE.

URGED by several correspondents, we purpose describing a few of the more important dynamo-electric machines adopted by the various electric lighting companies. The Gramme has been before the public about twelve years, and for this reason we refrain from giving a detailed description of it here. Nevertheless, it is only right that we should remind our readers that it was M. Gramme who first rendered the conversion of mechanical power into electricity practical. His machine may be said to bear the same relation to dynamos that the Daniell cell does to galvanic batteries, each being the first practical form, and still, for many purposes, the most efficient.

The Brush machine is one which has during the past two years commanded a great deal of attention, and whatever may be said of the various transactions in connection with it, it can scarcely be denied that it has done some really good work, and that, for arc lighting on a large scale, it is capable of standing its ground with any in the field. The machine is made in various sizes, Fig. 1 representing the one used to supply the current for sixteen arc lights, of 2,000 candle-power each, the weight of the machine being 2,200 lb. The inducing or field magnets consist of four massive pieces of iron, wound round with

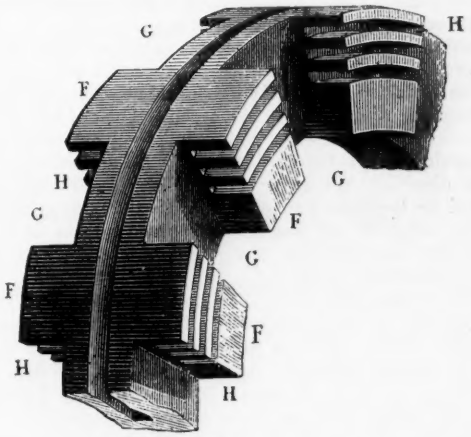
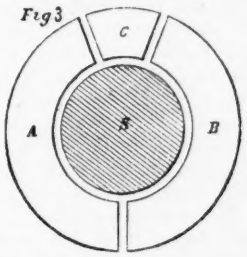


FIG. 2

stout copper wire (No. 10 gauge). Two of these (B B) are shown in the figure, the other two being exactly behind them. The inner face of each of the iron cones is flattened



out so as to extend nearly half way round the circle formed by the armature (A). By reference to Fig. 4, which is a typical horizontal section, it will be seen that the field magnets are joined together in pairs, M M and M^1 M^1, by

portions of the iron framework K K^1. The wire is coiled round the cores so as to make the adjacent pole-pieces, N N^1 and S S^1, of similar polarity, and is also continuous from B^1 round both field magnets to B^2 of the commutator (C, Figs. 1 and 4), of which more anon.

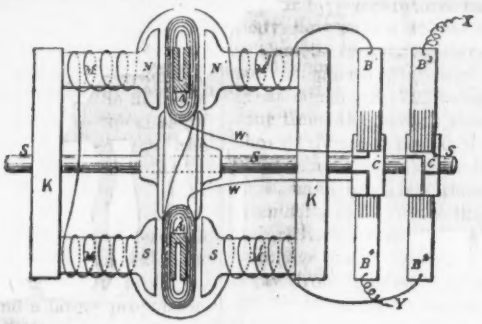


Fig. 4.

The armature (A, Figs. 1 and 4) is the most important feature in the Brush dynamo. It consists of a core of soft iron in one piece, and having wound round it, in specially-constructed grooves, a number of coils of copper wire. Fig. 2 represents a portion of the circular core, the grooves, G G, having parallel sides, so that the coils are of equal dimensions throughout. The coils are made sufficiently thick to be flush with the projections, F F, and so present almost perfectly level surfaces to the field magnets during the process of rotation. Round the core is a groove, C, which extends almost to the inner surface, while on both faces of the projecting portions are series of concentric grooves, H H.

The armature of the 16-light machine is twenty inches in diameter, and contains eight coils of No. 14 B. W. G. cotton-covered wire, each coil weighing about 20 lb., and containing about 900 feet of wire. All are wound in the same direction, the inner end of each coil being connected to the inner end of the coil, exactly opposite to it (there being in all machines an even number of coils). The outer ends all pass along the shaft (S S, Fig. 4) to the commutator, C^1 C^2.

The commutator is that portion of the machine where the various currents generated in the coils of the armature are collected and made to pass through the external circuit in one common direction. It is very unique, differing from all its competitors in more than one important feature. It is, of course, fixed on to the shaft, but instead of being in the form of a series of discs radiating from the centre of rotation, it consists of a number of copper rings or flat cylinders, there being a ring to each pair of armature coils. Each ring (Fig. 3) is divided into three parts, of which A is connected to one free end of a pair of armature coils, and B to the other end. C is quite isolated from the other segments, and is practically an insulator. Each of the three parts is separated from the shaft S by means of an insulating substance, and from each other by air-spaces. B^1, B^2, &c., are flat strips of copper, with a number of longitudinal cuts. They are about two inches wide, and are called brushes, their function being, by pressing against the copper rings as they revolve, to collect the current from the coils, or rather to connect the machine with the external circuit. As there are four pairs of coils in the armature of the machine being described, there are four rings, for which two pairs of brushes are provided—one pair for two rings. One of each pair presses above and the other below the rings, the points of contact being on the same diameter of the ring.

The consideration of the principles upon which this interesting machine is constructed we are compelled, by want of space, to defer.

THE MOON AND MAY FROSTS.

ALL gardeners dread the frosts which often come in May, after the vegetation has been stimulated into activity, and the plants are easily injured by a check. In France, the cold is popularly attributed to the moon which is new in April, and reaches its full at the end of that month or early in May. This moon is termed *la lune rousse*, because, during the clear nights it illuminates, young leaves, and buds freeze and turn red, although the air may be several degrees above the freezing point.

Louis XVIII. is said to have bewildered Laplace when he visited the *Bureau des Longitudes*, by asking him to explain how the *lune rousse* acted upon the crops. The great astronomer looked in confusion, and finally told the king that this moon had no place in astronomical theories, and in consequence the *Bureau* was unable to answer his question.

M. Mabillon, in an article on this subject, in *Ciel et Terre*, says that this story led Arago to investigate the subject, but he does not give the date of his inquiries. Wells explained such incidents in his celebrated "Essay on Dew," of which the first edition was published in 1814.

M. Mabillon quotes the following from a work of Plantin's, "Ephémérides Perpétuelles de l'Air," published at Antwerp in 1556:—"Si du vingt-et-cinquième d'Apvril jusques au vingt-et-huitième d'Apvril la pleine lune advenait, trouvat nuicts séreines et belles, sans aucun vent (auquel temps la rosée ha coûtume tumber a grâde planté) les anciens de longue expérience tenaient tout certain que les grains de la terre seraient endommagez." The reader will be amused with this old French. It means that when full moon comes between April 25 and 28, with clear nights and no wind blowing, "Dew has the custom of falling in great plenty, and long experience makes it certain that the crops of the earth will be damaged." If dew forms on nights when the clear air enables plants to lose much heat by radiation, they will receive it as hoar-frost; and if the air is too dry for much dew, the radiation may be stronger and their juices frozen, although the air is considerably warmer. "The formation of dew indeed," said Wells, "not only does not produce cold, but, like every other precipitation of water from the atmosphere, produces heat." Wells found that bodies on the surface of the earth become, during a still and serene night, colder than the atmosphere," and then he saw that the gardeners he had smiled at "in the pride of half-knowledge" were right in using a "thin mat or any such flimsy substance," to protect their plants. "On a clear night," he says, "in an open part of the country, nothing almost can be returned to us from above in place of the heat which we radiate upwards." The plants which suffer on the clear May nights receive no warmth to compensate for the heat they radiate. A cloudy sky is a protection, and so is a damp or misty one. The old writer already cited says that if the conditions he mentioned occur "on the seventh day of the Ides of May," corresponding with the 9th of our calendar, "or within three or four days later, vines and olives are in great danger." M. Mabillon states that in "the vine-growing districts, the people make artificial clouds by heaping up to the windward dry leaves, with green wood and resinous products, which they ignite some hours before sunset, and thus make a great smoke,

which spreads over the vineyards, and, by hindering radiation, protects the vines against the frost." It would be more correct to say that the smoke particles and moisture radiate back again much of the heat that would otherwise be lost by the plants. S.

DEATH AT THE PLAY.

THE failure to regulate the temperature of the theatres of New York results in the killing of from two to twenty persons, it is estimated, every night in the year. When the patrons of the drama assemble in most of the theatres, they find the temperature ranging from 50° to 60° Fahr. By the end of the first act it has reached 80°, and before the close of the second act, 90°. The heat then rapidly increases until 100° are scored, and even then scarcely stops. Just at the point of suffocation, the whole audience is hurried out into the cold night-air or rain, the operation of cutting off the gas occupying about one minute and forty seconds. The consequence of this fall of 80° of temperature in the twinkling of an eye is a chill or shock to the system which brings on pneumonia, malaria, fevers, colds, and all sorts of lung diseases.

Besides the injury to the health, the stifling heat of the theatres is to the spirits most depressing. Many of them being practically air-tight, one feels as if he had been sitting under an exhausted receiver. There being no ventilation, the vitalising properties of the confined air are soon exhausted. Mental and physical weariness and languor result, and a vacuity of mind and thought is manifest on both sides of the footlights. In short, the experiment of living for three or more hours without change of air has not been successful. To prevent death, sickness, physical exhaustion, and mental depression, places of amusement must be ventilated, and their temperature regulated.

The heat at such places should never be allowed to rise above 70° nor fall below 60°. The temperature of the United States Supreme Court-room at Washington is kept, by the order of the Chief Justice and his associates, at 68°. This is about the temperature that seems healthiest to average constitutions. To sit in an artificial temperature 5° above or below this is positively unhealthy. And such is the character of all our theatres, with but two or three commendable exceptions. They must be made habitable and healthy, and their temperature regulated by law or by public opinion.

A NEW SPECTROMETER.—Professor Clifton, of Oxford, has brought out a new spectrometer. In the ordinary instrument the axis round which the prism turns, and the axis round which the telescope turns, are generally at an angle to each other; but it is of importance that they should not be inclined in this way, hence Professor Clifton has made them coincident. There is, in fact, only one axis in the new instrument, the telescope, divided circle, and prism plate being fixed on one conical axis turned very true.

FORETELLING FIREDAMP ESCAPES.—It is well known that the escape of firedamp in mines is intimately associated with the height of the barometer, which thus becomes a means of foretelling when such escapes are most likely to occur. But, according to M. de Chancourtois, who has brought the matter before the French Academy, the danger is also increased by strain in the earth's crust causing or opening fissures in the coal, and he therefore proposes to fix sismographic apparatus at the head of every dangerous mine, in order to detect these strains and provide additional precautions against the gas.—*Engineering.*

Reviews.

TYNDALL ON SOUND.*

WE are glad to see a fourth edition of this valuable work, the most suggestive and the most interesting treatise on sound in the English language. The work itself is so well known that it should be unnecessary to dwell here upon its merits; but the new edition contains some important additions. The descriptions of the telephones of Bell & Edison, and of the microphone and phonograph, will be read with interest even by those who are already well acquainted with all these instruments. We should have liked to have had here Professor Tyndall's opinion as to the probable future of the phonograph. It is well known that the original descriptions of its performances were considerably exaggerated. The sounds which it was said to repeat were repeated in a sense, but verily they were considerably translated. To recognise in them the original words one had "to make-believe a good deal." The microphone is another instrument which promised (one may say it promises) to do much more than it has hitherto performed. We should have been glad if Professor Tyndall had shown how full of promise this instrument is.

The experiments on the action upon sound (as respects velocity) of soap-bubbles filled (1) with nitrous oxygen, and (2) with hydrogen, are singularly instructive in their bearing on the phenomena of light. The fog-signalling observations have been somewhat amplified, and are rendered clearer by the use of maps. Besides these additions, the methods and results of Professor Tyndall's experiments in the "Action of Free Molecules on Radiant Heat," are here set forth, and an explanation of the singular phenomenon of "'Soundless Tones,' observed by General Douane around Fog-signal Stations on the Coast of the United States," is reproduced and illustrated.

BRIDGING THE NIAGARA.—The Canada Southern Railway Company is said to have closed a contract with the Phœnix Bridge Company for the construction of a new iron suspension bridge across the Niagara. The bridge, which will be about a quarter of a mile south of the old Suspension Bridge, is to be ready for trains to cross by Sept. 1, 1883, after which date the Canada Southern Company will not use the International Bridge, at Buffalo, or the old Suspension Bridge, and will thus avoid the payment of the heavy tolls hitherto levied.

LUMBER IN CANADA AND THE UNITED STATES.—It appears that there are no fewer than 15,024 saw mills in the United States, and 637 in Quebec, Ontario, and Manitoba. In these mills during last year, nearly 750,000,000 ft. more timber was manufactured than in the year 1881. Towards the close of the year, moreover, new mills were being built in every direction, so as to be ready for work this spring. Work in the woods has prospered in consequence of the favourable weather, and the lumberman looks for an increase of 15 per cent., and even more, if the weather continues to be in good condition for floating the logs down. It is confidently stated that, from all present indications, the production of pine lumber in the North-West for the year 1883 will be the largest ever known. The prices realised by manufacturers on the stocks sold in 1881 and 1882 were high, and the business profitable. This fact has given a great stimulus in the direction of the further expansion of the great lumber trade.

* "Sound." By John Tyndall, D.C.L., &c. Fourth Edition, revised and augmented. (London: Longmans & Co., 1883.)

XUM

Editorial Gossip.

So many readers express (despite our protest) the request that Gossip should be resumed, that in a modified form we resume it. The few grumblers may take it or pass it by as seems best to them. We are not willing to go counter to the wishes of a great number of kindly readers for the sake of a few unkindly ones. It has been the same with the Answers to Correspondents. Having in each case tested the real wishes of the great majority of our readers, we shall not in future notice objections.

The *Oxford Chronicle and Bucks and Berks Gazette* is upon me yet again. It will not accept my explanation that we misspelt Dr. Collins Symon's name quite accidentally. "He had the name," it says of me, "at full length in every article of ours he has commented upon." I had, it is true, but how long does the *O. C. & B. & B. G.* imagine I had the articles by me? When I wrote the paragraph complained of I was on a lecturing tour, and, as I quite correctly explained, "I had not book, pamphlet, letter, or even card to remind me how the name is spelled." But there are men who (judging, perhaps, from internal evidence) are ever prone to suspect falsehood. I can only say to the writer of these rude remarks, You may, perhaps, know yourself—you do not know me. He remarks further that Dr. Symon offered a prize of fifty guineas, not to one who would convince Dr. Symon of the absurdity of his paradox, but to one who would convince any three professors chosen by [*me* of all people, but he means] the acceptor of the challenge. I am aware of it. The offer proves that Dr. Symon feels assured of the truth of his views, but it also proves that he is quite unfamiliar with the ways of men of science. They do not accept proffers of this kind any more than gentlemen and men of probity accept such proffers as "I'll lay you a guinea a crab is a fish," or "I'll bet you a pony the sun goes round the earth." Dr. Symon's proffer was not in very good taste, and the silence of men of science has been its appropriate rebuke. If I have broken this silence it has been only because he has so loudly expressed his belief—which, doubtless, he honestly entertains—that silence means assent.

The *Oxford Chronicle* now promises to supply its readers with "a concise statement of the whole principle, from the pen of its discoverer." I wish these readers joy of the scientific treat promised them.

In our last, a rather curious misprint occurred at p. 279 under heading, "Erewhon News." For "*hiatus valde deflendus*," there appeared the new reading, "*hiatus valde defendus*" (save us, also!). Circumstances prevented us from seeing proof.

On Sunday evening, *twenty minutes after sunset*, a rainbow was visible in the east. It was remarkable for the excess of red in its colouring, the spectrum not reaching beyond the yellow-green. The source of light seems to have been a singularly luminous patch of red cloud in the west, close to the horizon.

Shortly after nine o'clock on Sunday evening M. Borelly, of the Marseilles Observatory, discovered a new minor planet. It is of the eleventh magnitude, and can therefore only be observed with large telescopes.

"Let Knowledge grow from more to more."—Alfred Tennyson.

Letters to the Editor.

Only a small proportion of Letters received can possibly be inserted. Correspondents must not be offended, therefore, should their letters not appear.

All Editorial communications should be addressed to the Editor of Knowledge; *all Business communications to the* Publishers, *at the Office, 74, Great Queen-street, W.C.* If this is not attended to, delays arise for which the Editor is not responsible.

All Remittances, Cheques, and Post Office Orders should be made payable to Messrs. Wyman & Sons.

The Editor is not responsible for the opinions of correspondents.

No communications are answered by post, even though stamped and directed envelope be enclosed.

SATURN'S RINGS.

[815]—In reference to Mr. Rix's letter (797) on this subject, I must say that having also carefully examined Ball's original paper cutting in the archives of the Royal Society, I am quite unable to agree with the conclusion that the paper was only once folded. On folding longitudinally a careful tracing which I made of it, I find the correspondence in the form above and below to be *perfect*—not only as regards the outside form of the ring, but also the spaces between the planet and the ring. It is inconceivable that this perfect symmetry can have been the result of either skill or chance (as any one will find who tries to make such a cutting for himself), and I can only conclude that the paper was twice folded when the cutting was made, as suggested by Professor Adams.

There is undoubtedly now no trace of a longitudinal fold, while the vertical sold is very distinct, but it is quite possible that the paper was not *strongly* folded longitudinally, while the cutting may have long been kept folded in the other direction. In the tough, old-fashioned paper, too, the fibre would be less readily broken, and the fold consequently less marked than would be the case with most modern paper.

W. H. Wesley.

Burlington House, April 28.

RATIONAL DRESS.

[816]—Having taken much interest in the correspondence upon Rational Dress which has appeared in Knowledge, perhaps you will allow me to make a suggestion, which I hope may be useful to many. One of the most important points to keep in mind is, that when a woman discontinues to wear corsets she must be careful also to discard all heavy skirts suspended from the waist. It is a very good plan (and I write from considerable experience) to have a sleeveless bodice attached to all heavy skirts. If this fits to the figure, it supplies the support referred to by C. Carus-Wilson, in your issue of April 20; and the weight of the skirt is borne by the shoulders, which is, I think, rational.

Ladies, by adopting this bodice, can wear any dress with comfort; and few even of the gentle sex would be able to say whether they wore corsets or not, unless by observing their freedom in all movements.

E. Y.

SHAM THOUGHT-READING.

[817]—Now that the parlour pastime, the Willing game, has developed into thought-transference—or, as it is popularly termed, thought-reading—and in this form is the subject of special investigation by the Society for Psychical Research, I may be allowed to call attention to Professor Thorpe's very clever exposure of sham thought-reading.

In illustrating his lecture the other night, he introduced a couple of telegraph experts, one blindfolded in the orthodox fashion, and by merely grasping hands, they were able to keep up a secret telegraphy, and perform all the audience required. By difference of pressure on the hand, dots and dashes of the Morse code were represented, and a communication kept up between thinker and reader.

The best public exponent of genuine thought-reading is a young Wesleyan minister, Rev. E. H. Sugden, B.A. This gentleman also illustrated Professor Thorpe's lecture, and discovered, blindfolded, the number of a bank-note, and wrote on a black-board a word *thought of*, but *not spoken*, by the person whose hand he held. I should be glad to hear of well-authenticated cases of thought-reading *without* contact, of which we hear so much, and to which the usual explanation of unconscious muscular action could not be applied.

WILLING.

PROBLEM IN CHANCE.

[818]—A short time back you had in KNOWLEDGE some papers on probabilities and chances, and I should like to put before you rather an interesting example, and should be glad if you would inform me how to correctly solve it.

The editor of the *Sporting Times* is issuing a new paper called *The Prize Winner*, in which he offers certain prizes for picking a certain number of winning horses out of ten given races, as a bait to subscribers. The chief prize is £100 for picking all the ten winners. Now, if we say there are five horses in each race to pick from, is not the chance of picking all the ten only $\frac{1}{5^{10}}$ or $\frac{1}{9{,}765{,}625}$?

If the £100 is not taken, there is another prize for picking five winners or more out of the ten races—let us say, six winners out of ten races.

Now, to pick six winners out of six races, in each of which there are five horses to pick the winner from, the chance here would be similarly $\frac{1}{5^6}$; but as we have ten races, out of which six winners may be picked, the chance of naming the six is increased, and in what way to arrive at the actual increase here, I do not know.

A. M. T.

[I leave the problem for a week or two, as an exercise for our readers, noting only that in all such cases the offerer of the prize takes a tremendous advantage of subscribers.—R. P.]

LOGICAL PUZZLEDOM.

[819]—I think you are too hard on the logicians, both in what you (apparently) expect them to do and in your comments on what they have done.

The puzzle which you really set them is this: To exhibit syllogistically a piece of reasoning which is purely arithmetical, and to do this in a single syllogism (at all events, I can anticipate the comments which you would make if I sent you three or four syllogisms, the last of which led to the conclusion in question), without expressing the arithmetical axioms assumed. If logic cannot do this (or finds great difficulty in doing it) you conclude it to be worthless.

Now, Sir, in the first place, no logician, I believe, contends that all reasoning is, or ought to be, reduced to syllogistic form. What he contends is that all right reasoning *can* be reduced to one or more syllogisms, and that, therefore, when we have discovered the tests which distinguish good from bad reasoning in syllogisms (such as, for instance, undistributed middle, illicit process, or ambiguous terms), we can apply these tests to ordinary reasoning without actually performing the reduction. To show that logic is useless, it should be shown either that these tests are useless, or that men spontaneously apply them without any logical training.

But, in the second place, all logicians, I believe, admit that the reduction of ordinary reasoning to syllogistic form must be left to the reasoner himself, and that no cut-and-dried rules can be laid down for its performance. To which I may add, that while some simple and obvious arguments require a good deal of trouble in reduction, other arguments which are by no means simple can be reduced to syllogistic form without difficulty. You will not, I think, find much difficulty in turning the following argument into a syllogism:—The universe is constantly parting with its heat; for it is radiating it away into the space which surrounds it, and the greater part of this radiant heat, meeting with no solid body in its path, never returns. But is this reasoning correct? I think you will not find it easy to give an answer.

W. H. S. MONCK.

[I merely said that, without any training in formal logic, the particular relation presented by Professor De Morgan ought to be obvious. The falsity of the reasoning at the close of our correspondent's letter lies in the assumption that the universe is surrounded by space, which is no more correct than would be the assumption that space is surrounded by the universe. The broad fact that among the ablest reasoners the world has known, nine out of ten have known nothing of formal logic, or, knowing its rules, have never thought of applying them, is that on which I would alone dwell in discussing the value of the study of logic. Yet in its proper place, and in proper degree, the study of logic is excellent for the mind, precisely as the study of mathematics is good even for those who never care to use mathematics in their actual studies.—R. P.]

ALTERATION IN COAST LINE AND SUBMERGED FORESTS.

[820]—As supplementing and correcting some statements by "H'sett" (768), p. 183, allow me to say that on the NE coast of Sheppey the rate of waste is about a quarter of a mile in a century, not 3 ft. I can advance proof that during the last 300 years the line of cliff has receded three-quarters of a mile.

Warden Church was pulled down some years ago, when its position became dangerous, and during this last winter its site and the whole of the graveyard have slipped away. Before long, on the beach below, human remains will be as plentiful as fossils.

Minster Church and village are now little more than a quarter of a mile from the sea, so that in another 100 years these will probably be swept away, unless in the meantime the process of waste be stopped by an embankment.

Will "H'sett" state what evidence there is of an ancient forest having been discovered below the surface at Sheerness? Drift timber is plentiful enough in the London clay, and may also occur in the alluvium which—60 or 70 ft. thick—overlies this at the spot indicated; but drift timber in a sedimentary deposit is a very different thing from a submerged forest, indicating an old land surface.

The skull of the enormous turtle (*Chelone gigas*), which I found some time ago, is now in the Natural History Museum at South Kensington.

W. H. SHRUBSOLE.

HOW TO USE THE EYES.

[821]—Like yourself, I am particularly interested in this question, and hope to see it fully discussed in the pages of your valuable Journal. The points I wish to refer to, however, will hardly come within the province of the author of the above papers to deal with, and it may not be out of place for me to seize the opportunity—suggested by your note appended to a letter by "Myopia"—of stating a case, which, although it may be rather a side-issue, may yet have some claim to come under the subject of "How to use the eyes." It is this, that, as in your own case, I have one eye much more short-sighted than the other, and that I *see double*. But the ordinary position of one of my eyes is what is known as an outward "squint," and it is only when I bring this eye to look straight with the other that I have *double and also indistinct vision*.

Of course, any one may at pleasure so adjust his sight as to see double, but the question is, how is it that in this case double vision is always the result of this experiment? If an oculist were to operate and correct the squint, would the result be double and indistinct vision? This would be an important consideration, and as I have often wished to have the operation performed, perhaps some of your correspondents who may be able to speak with the authority of experience in the matter, will kindly give me their opinion.

There may be many cases similar to my own, and of course the correction of such a defect would be a great advantage to the individual concerned; but before tampering in any way with the eyes, let us be certain, as far as possible, of results. I have been advised on both sides—for and against the operation—by medical men, some years ago, but would now like to have the testimony of any one who may have had such a case brought under his notice.

OCULUS.

WART-CHARMING.

[822]—I am not a believer in any one of the occult "sciences." I am of opinion that many extraordinary things, when sifted, would prove to have no better basis than a garbled account of some actual fact, totally different and altogether unimportant; but what am I to make of this? A gentleman now sitting before me, whose mind is as sceptical as my own, tells me that five-and-thirty years ago, when he was about fifteen years of age, his hands were unsightly from warts. When out for a walk with his father he called upon an acquaintance, who noticed them, and said that if he would call upon him during the week he would remove the warts. The youth went, and was told to sit down and count his warts. Some were partially grown together, and he put the question as to whether he was to count them as one, or two, or three, as the case might be. The answer, somewhat abruptly given, was, that he must count his warts, and say how many he thought he had. The "charmer" left the room for a minute, came back, asked for the number, and told the youth that would

do and he might go. The youth went away half-laughing and half-disgusted at the apparently ridiculous way in which he thought he had been humbugged, and dismissed the incident from his mind. He had, as near as he can now recollect, twenty-three warts. He happened to recall the incident a fortnight afterwards, glanced at his hands to see that they were still there, and found, very much to his surprise, that all had disappeared but one upon the pad of the thumb, and that was the only one upon the under side of the fingers, and it remained for years afterwards. My friend has, in the course of his life, found many other cases of successful wart-charming. I have often heard, but never noticed, such tales until now, but it is impossible for me to doubt either my friend's recollection of the event or his veracity and good faith.

What am I to make of this? Puzzled Sceptic.

[Bacon (Francis) gives similar experience of his own, which I have quoted in an article on the Influence of the Mind on the Body. What kills the warts in such cases is undoubtedly the attention directed to them. That is the *How*, but as to the *Why*—*Quien sabe?* R. P.]

POISON IN THE CUP.

[823]—Referring to the custom of serving ale and stout in pewter pots which are never washed, I ask you, in the name of cleanliness, decency, and common sense, to help in putting down this dangerous custom, which I am sure is the cause of much disease, more particularly in the City of London and the neighbourhood, where the great unwashed pewter is so much more used than the cleaner glass, which must be washed, or show its uncleanliness.

It is notorious that in all the great luncheon and dining rooms in the City, the City clerk and others who have not much spare cash, order their half-pint in preference to asking for a glass, which contains about a halfpenny worth less than the half-pint; or, in other words, for less than one halfpenny he will run the risk of getting all manner of complaints, which he in turn may communicate to others, and all for one halfpennyworth of beer.

Our railway companies are obliged to clean out and whitewash their railway trucks for fear of spreading cattle diseases. Is not a human being as good as an ox, and should not our publicans be obliged to do as much for their fellow creatures as the law compels a railway to do for cattle?

If anyone doubts that pewter pots go from day to day—yes, and from week to week—without washing, until they are so sticky they cannot be handled, let him watch, or ask any bar girl, and he will find, as I have done, that they will not reply—from which you can draw your own conclusions. I have, at some little trouble, made some inquiries, and find that the working man's public-house is vastly cleaner than our palatial restaurant. Now, the question is, how to mitigate the evil? To name the places in question and caution the public against going there might bring improvement for the time, but for the time only. Therefore, I hope some discussion may be brought on, and that Parliament may be induced in future legislation to give the same protection to man as it does to a beast, or else that some society will make it their business to oppose all licences where common cleanliness is not observed.

Health before Beer.

THE OLDEST TREE IN THE WORLD.

[824]—In the number of Knowledge for January 19, 1883, is an article headed thus; and also in a number of the same paper for March 2nd this year, is one headed the "Bo-tree and the tree of Knowledge." In both of them statements are made which may lead people into error.

"A. M. L. J.," the writer of the latter article, seems to confound Buddhism with Brahminism, and to imagine them to be one and the same religion, because he found the pipal (*Ficus religiosa*). Bodhi or Bo-tree sculptured on Buddhist remains, and saw its leaves offered to one of the Hindu gods.

With regard to the former article, we would refer your readers for what we believe to be a true account of the Bo-tree to a work which has just appeared, entitled "Our Tour in Southern India," by Mrs. J. C. Murray-Aynsley, in which, at page 305, is given the account of the introduction of one of its offshoots to Ceylon; and at page 354 we are told where the original Bo-tree came from. According to this work, an offshoot of the tree under which Buddha attained Nirvana was brought to Anaradhapura, in Ceylon (not Amarapoora, in Burmah), B.C. 289, from a place called Buddh Gaya, no great distance from Patna, in Bengal, where was the original Bo-tree, pipal, or *ficus religiosa*, under which Buddha is said to have remained five years until he attained Buddhahood or Nirvana. The pipal is stated to live only about three centuries. It is a soft-wooded tree, which we believe renders this highly probable; and when Mrs. Murray-Aynsley visited Buddh Gaya in 1881 she was told that a year or two previously the old pipal tree had fallen down (owing to the giving way of the masonry which surrounded it), *after it had been dead some years*. And she states that the present sacred tree is a seedling from the last, and quite a small tree, only about fifteen-feet high, and that its trunk is covered with gold-leaf.

Perhaps some of your readers in India may be able to confirm or disprove the statement here made respecting the ordinary age attained by the pipal tree. I have spent several years in India, and do not recall ever seeing a tree of this species which appeared to be of a very great age. Cosmopolitan.

LETTERS RECEIVED AND SHORT ANSWERS.

W. B. That 365d., or a penny a day for a year = £1. 10s. 5d. is too obvious to need a special letter; but, as you say, it gives a convenient way of quickly calculating how much a daily number of pence will give per annum, counting Sundays. As to the cat's-tail paradox, we must beg to be excused. Surely you did not fail to see that Mr. Foster was only jesting in his paradox about Mercury. As for "An Observer," I am not sure whether he was jesting or not about tight-lacing. I fancy he was, or was testing his skill in advocacy. Anyhow, he is one of the ablest men of the day.—W. B. To quote the pleasing words of your own letter (there *can* be no "acrimony" in that), "you would not, pardon me, have made an ass of yourself, by writing as you have" (really that sounds rough, but it must be right, as you put it that way), if you had known more of the facts. I know—you evidently do not—that not he alone, but several entertain precisely that mistake; I had a reason, that you could not appreciate, for entering on the discussion (which took precisely the course I had anticipated); and, lastly, I know that the originator of the theory is no more mad, and no more believes in the theory, than you—to judge from the sentence partly quoted above—know anything (pardon me) of manners (you will excuse me). I trust *this* also will prove "vastly entertaining to you and your friends." —P. M. Yearsley. Not easy to say without fuller particulars.—Florian. I think it was only a long beam of light passing through two low-lying banks of cloud.—Barpeta. It is impossible to say what would suffice to make the matter clear to Dr. Simon and his followers. Have no space to attempt the Herculean labour.—C. J. Caswell. Quite agree with you. As to place of Venus, I owe you many apologies; will attend to the matter at once.—E. C. H. Your reply does not cover the question, which refers to one and the same chord.—A Constant Subscriber.—The writer you quote seems quite right. When he speaks of the face of the sun, he means, apparently, the visible disc; but, as I have not seen the article, I cannot be certain. Science knows of no dark face of the sun, seen through the spots.—G. M. Much to be said about interplanetary ether, but such talk is pretty barren. Too crowded just now for the suggested article, the title of which suggests rather ethical than physical matters.—H. R. B. Simple, yet useful. I think no one wants it explained. Thanks.—W. H. J. Just the sort of information we do not undertake to give.—T. M. Purday. Many thanks. Pamphlet most interesting.—G. W. Valentine. Noted. —F. Mounsdon. Partial halo.—Æon. Consigned, as per request, to locality indicated (oblivion).—A. M. Mitchison. Thanks. Will use.—LL.B. Leibnitz's definition implies only evenness, not constancy of direction.—J. Redosman. Query column closed.—Joseph Hibbert kindly points out that the translation of Richter's "Dream of the Universe" is in Vol. XIII., p. 134, of De Quincey's works, published 1863, by A. & C. Black.—W. Thanks.—Hugh Clements. No connection whatever has been made out.—E. C. H. On the contrary, for one letter maintaining that the man does not go round the squirrel we have received a score holding the correct view; but the real point at issue is the interpretation to be given to the words rotation and revolution. The paradox that the moon does not rotate because she turns always the same face to the earth is maintained by not a few, and is precisely akin to the one involved in your argument.—John Herbert. Possibly weather unfavourable. Cannot answer so many small queries here, and query column long since closed.—A. Latham. Regret that am unable; but it would involve a heavy annual expense to do so in every case, and cannot make selection.—E. A. Brown, J. Hargreave, L. Mathews, and many others. The gossip notes (non-personal) continue.—Subscriber. Thanks.—J. Parry. Many like you have disregarded that request; and, of course, I am not sorry they have done so.—J. K. Dealy. Will try to find room, but am doubtful.—H. W. M. Thanks; but subject unsuitable.—Jas. Hornell. Query column closed long since.—Peccavi. Pretty seal, yours! Are not microscopical papers in progress? Marvels of pond life will come in naturally.—C. E. Bell. See Mr. Goschen's letter. —C. N. That (with regard to the Pyramid) "is what I intended to convey officially."

Our Mathematical Column.

COLLECTING the results we have obtained in the last two lessons, so far as they add to the number of our known integrals, we have

$$\int\sqrt{a^2-x^2}\,dx=\frac{x\sqrt{a^2-a^2}}{2}-\frac{a^2}{2}\sin^{-1}\frac{x}{a}$$

$$\int\sqrt{x^2-a^2}\,dx=\frac{x\sqrt{x^2-a^2}}{2}-\frac{a^2}{2}\log\left(x+\sqrt{x^2-a^2}\right)$$

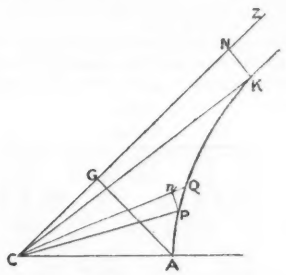
$$\int\sqrt{x^2+a^2}\,dx=\frac{x\sqrt{x^2-a^2}}{2}+\frac{a^2}{2}\log\left(x+\sqrt{x^2-a^2}\right)$$

$$\int\frac{dx}{\sqrt{x^2-a^2}}=\log\left(x+\sqrt{x^2-a^2}\right)$$

$$\int\frac{dx}{\sqrt{x^2+a^2}}=\log\left(x+\sqrt{x^2-a^2}\right)$$

These results should be committed to memory, because these logarithms are of frequent occurrence. As for the first, it is easily remembered from the relation which, as already pointed out, it bears to a circular area. The next two are similarly related to the areas A P K N and C A′ K′ N in Fig. 1. Also, if A K, A K′ be joined, it will be seen how the first part of the one represents the triangle C K N, while the first part of the other represents the triangle C K′ N—the logarithmic parts represent respectively the areas A P K C and A′ P′ K′ C. These areas, then, are represented by the fourth and fifth of the above tabulated integrals.

It remains, then, to be ascertained whether the curved surfaces, A C K, A′ C K′, can be at once and so readily shown to be represented by the fourth and fifth integrals, that a convenient aid to the memory may be obtained from the relation. Obviously, the



only way to get these areas is to proceed by polar formulæ. Thus, let A P Q K be part of a rectangular hyperbola, C the centre, C A the axis. Then we know* that if C P = r, and A C P = θ

$$r^2=\frac{a^2}{\mathrm{Cos}^2\theta-\sin^2\theta}=\frac{a^2}{\mathrm{Cos}2\theta}$$

Now, if P C Q = $d\theta$, we have, elementary area P C Q

$$=\frac{r^2}{2}d\theta=\frac{a^2d\theta}{2\cos2\theta}$$

and if K C A = α, we have

$$\text{area A P K C}=\frac{a^2}{2}\int_0^{\alpha}\frac{d\theta}{\cos2\theta}$$

Thus to integrate $\int\frac{d\theta}{\cos2\theta}$ and $\int\frac{d\theta}{\sin2\theta}$ is our next care.

Take the second first, as more likely to be easy. We have

$$\int\frac{d\theta}{\sin2\theta}=\int\frac{d\theta}{2\sin\theta\cos\theta}=\int\frac{\cos\theta\,d\theta}{2\sin\theta\cos^2\theta}$$

$$=\tfrac{1}{2}\int\frac{1}{\tan\theta}\cdot\frac{d\tan\theta}{d\theta}\cdot d\theta=\tfrac{1}{2}\log\tan\theta$$

Whence we obtain $\int\frac{d\theta}{\cos2\theta}$ very easily. Thus,

Put $\theta=\frac{\pi}{4}-\phi$; so that $\frac{d\theta}{d\phi}=-1$

then $\int\frac{d\theta}{\cos2\theta}=\int\frac{1}{\sin2\phi}\cdot\frac{d\theta}{d\phi}\cdot d\phi=-\int\frac{d\phi}{\sin2\phi}$

$$=-\frac{1}{2}\log\tan\phi=-\frac{1}{2}\log\tan\left(\frac{\pi}{4}-\theta\right)$$

$$=\frac{1}{2}\log\cot\left(\frac{\pi}{4}-\theta\right)$$

Hence area A P K C

$$=\frac{a^2}{4}\left[\log\cot\left(\frac{\pi}{4}-\alpha\right)\right]\qquad\left(\because\log\cot\frac{\pi}{4}=0\right)$$

$$=\frac{a^2}{4}\log\cot\text{K C N}$$

$$=\frac{a^2}{4}\log\frac{\text{C N}}{\text{N K}}.$$

$$=\frac{a^2}{4}\log\frac{\text{C N}^2}{\text{C N}.\text{N K}}\qquad\text{or}=\frac{a^2}{4}\log\frac{\text{C N}.\text{N K}}{(\text{N K})^2}$$

$$=\frac{a^2}{4}\log\frac{(\text{C N})^2}{\text{C G}^2}\qquad\text{or}=\frac{a^2}{4}\log\frac{(\text{A G})^2}{(\text{N K})^2}$$

$$=\frac{a^2}{2}\log\frac{\text{C N}}{\text{C G}}\qquad\text{or}=\frac{a^2}{2}\log\frac{\text{A G}}{\text{N K}}$$

We have seen already that A Q K C, fig. 3 = G A K N. Hence the result just obtained shows that we may write—

$$\text{Area G A K N}=\frac{a^2}{2}\log\frac{x_1}{a_1}\quad\text{or}=\frac{a^2}{2}\log\frac{a_1}{y_1}$$

(putting N K = y_1). This is, of course, obvious, since $(a_1)^2=x_1\,y_1$, that is,

$$\frac{a_1}{y_1}=\frac{x_2}{a_1}$$

But it is convenient to note the two forms.

Putting $\alpha=\frac{\pi}{4}$, or carrying the radius vector on to coincidence with the asymptote C Z, we find that the area between the asymptote, the semi-axis C A, and the curve A Q K to infinity

$$=\frac{a^2}{2}\log(\cot0)=\text{infinity}.$$

We may here add to our list of known integrals these:—

$$\int\frac{d\theta}{\sin\theta}=\log\tan\frac{\theta}{2}\quad\text{and}\quad\int\frac{d\theta}{\cos\theta}=\log\cot\left(\frac{\pi}{4}-\frac{\theta}{2}\right)$$

$$\int\frac{d\theta}{\sin2\theta}=\frac{1}{2}\log\tan\theta;\quad\text{and}\quad\int\frac{d\theta}{\cos2\theta}=\frac{1}{2}\log\cot\left(\frac{\pi}{4}-\theta\right)$$

$$\int\frac{d\theta}{\sin n\theta}=\frac{1}{n}\log\tan\frac{n\theta}{2};\quad\text{and}\quad\int\frac{d\theta}{\cos n\theta}=\frac{1}{n}\log\cot\left(\frac{\pi}{4}-\frac{n\theta}{2}\right)$$

* We give, in fact, the well-known polar equation of the rectangular hyperbola; but it can be deduced at once from the relation already given: $y^2=x^2-a^2$; putting $y=r\sin\theta$, and $x=r\cos\theta$.

Our Chess Column.

BY MEPHISTO.

THE INTERNATIONAL TOURNAMENT.

SINCE our last report Steinitz sustained an important defeat by Blackburne on the 11th inst. From the game which we publish below it will be seen that Steinitz adopted the same defence of 3. P to KKt3 as in his game with Mackenzie and Zukertort, but this time with fatal result. This, however, did not come as a surprise to many, who had no faith in that line of play. Blackburne has raised his score to six, and he has two more draws to play off. Zukertort does not seem to be much affected by his only defeat of last week by Steinitz. He defeated Sellman, Bird, and Rosenthal in very good style, and heads the list with a score of ten. He has to meet English and Winawer before the conclusion of the first round, and it is possible he may have to yield the palm of victory to one or other of these two strong players. Nevertheless, he ought to come out at the head of the list at the first round. Tschigorin has done very well indeed, having lost but three games out of ten. Next come Mason and Winawer, with a score of five-and-a-half each, and two draws to play off.

The play itself is excellent, and continues to interest a large number of daily visitors. Some of the dailies also give considerable attention to the Tournament, notably the *Evening Standard* and

the *Morning Advertiser*. Especially in the latter paper our readers will find a reliable daily report.

SCORE UP TO MONDAY NIGHT.

	Bird	Blackburne	English	Mackenzie	Mason	Mortimer	Noa	Rosenthal	Sellman	Skipworth	Steinitz	Tschigorin	Winawer	Zukertort	Draws not counting	Total score
Bird	—		1	1	0	1	0		1	0	0	1	0	5		5
Blackburne		—	1	0		1	1		1	1	0		0	6		6
English	0	0	—			1	1		1		1	1	0		5	5
Mackenzie	0	1		—	0		1			1	0		0	0	4	3
Mason	1			1	—		½	1	1	1	0			0	5	5½
Mortimer	0	0	0			—	0	0	0	0	0	0	0	0	1	0
Noa	1	0	0	0	½	1	—		0	0	0	0		0	3	2½
Rosenthal					0	1		—	0			1	½	0	9	2½
Sellman		0	0		0	1	1	1	—	0		0	0	0	4	3
Skipworth	0	0		0	0	1	1		1	—	0		0	0	2	3
Steinitz	1	0	0	1	1	1	1			1	—	0	1	1		8
Tschigorin	1	1	0			1	1	0	1		1	—	1	0	1	7
Winawer	0		1	1		1		½	1	1	0	0	—		6	5½
Zukertort	1	1		1	1	1	1	1	1	1	0	1		—	1	10

PLAYED IN THE FIRST ROUND ON MAY 11.

White. Blackburne.	Black. Steinitz.	White. Blackburne.	Black. Steinitz.
1. P to K4	P to K4	15. QR to Q sq	P to B3
2. Kt to KB3	Kt to QB3	16. B to B4	B to Q2
3. Kt to QB3	P to KKt3 (*a*)	17. B takes Kt	R takes B
4. P to Q4	P takes P	18. P to B5	Kt to B sq
5. Kt takes P	B to Kt2	19. P to K5 (*e*)	BP takes P
6. B to K3	Kt to B3	20. Kt to K6 (ch)	B takes Kt
7. B to K2	Castles	21. P takes B	R to K2 (*f*)
8. Castles	Kt to K2 (*b*)	22. Q to Kt5	Q to K sq (*g*)
9. B to B3	P to Q3	23. R to Q3	R takes P (*h*)
10. Q to Q2	Kt to Q2	24. R to R3	Q to K2 (*i*)
11. B to R6	Kt to K4	25. Q to R6 (ch)	K to Kt sq
12. B takes B	K takes B (*c*)	26. R to B8 (ch)	Q takes R
13. B to K2 (*d*)	P to KB3	27. Q takes RP mate (*j*)	
14. P to B4	Kt to B2		

NOTES.

(*a*) Steinitz favours P to KKt3 as a defence to the Four Knights' and Ruy Lopez attack. Most analysts, however, condemn that move, as leading to an unsatisfactory position in general and a weakness on the King side in particular.

(*b*) Played with the intention of advancing P to Q4.

(*c*) Black's position being already cramped, he ought to have simplified the game by Kt takes B (ch). This would, at least, have averted the subsequent speedy dissolution of his game.

(*d*) A judicious retreat, which prepares for the advance of the KBP.

(*e*) A very fine move, played in Blackburne's best style. Of course, the QP cannot take an account of Kt to K6, and on the BP taking, he obtains the full command of the B file.

(*f*) 21. R takes R, would have given White an obvious advantage. Also 21. R to B3, White would have replied with 22. Kt to K4, R takes P, 23, Kt to Kt5, R to K2, 24. R to B7 (ch), and should win.

(*g*) White threatened R to B7 (ch).

(*h*) Every move of this well-planned attack seems the natural outcome of the position. 23. P to R3 would not have helped Black much, for White would reply with 24. Q to B6 (ch), K to Kt sq. 25. Kt to K4, with a winning position; for if now 25. R takes P, one of the likely continuations would be 26. Q to R4, P to Kt4, 27. R to Kt3, &c.

(*i*) This allows of a mate in three moves, but Black had no real resource.

(*j*) A worthy finish to a well-conceived attack. As a curiosity, we may mention that Blackburne beat Steinitz at Vienna in the same number of moves, viz., 27.

PLAYED IN THE FIRST ROUND ON MAY 7.

White. Mackenzie.	Black. Bird.	White. Mackenzie.	Black. Bird.
1. P to K4	P to K4	24. P to KKt4	B to Kt3
2. Kt to KB3	Kt to QB3	25. Kt to B2	B to R2
3. B to Kt5	Kt to Q5 (*a*)	26. Q to Kt3	B to Kt sq
4. B to R4 (*b*)	B to B4	27. P to Kt5 (*g*)	B takes Q
5. P to B3	Kt tks. Kt(ch)	28. P takes Q	B to R5
6. Q takes Kt	Kt to K2	29. P takes P	R to Q sq
7. Q to Kt3	Castles	30. Kt to Q4	R to B3
8. Q takes P (*c*)	P to Q4 (*d*)	31. K to Kt2	K takes P
9. P to Q3 (*e*)	P to QR4	32. Kt to Kt3	R to B4
10. Castles	R to R3	33. P to Q4	K to R3 (*h*)
11. P takes P	R to KKt3	34. R to Q2	R to KKt sq
12. K to R sq (*f*)	B to Q3	35. B to K4	R to Kt4 (ch)
13. Q to K2	Kt takes P	36. K to B3	P to KB4
14. P to KB4	B to KKt5	37. B to B2	R to K sq (*i*)
15. Q to KB2	P to QB3	38. Kt to B5	B to R4 (ch)
16. B to Q sq	B to KB4	39. K to B4	R to Kt5 (ch)
17. B to K2	R to K sq	40. K takes P	R(Kt5)toKtsq
18. R to Q sq	R(Kt3)toK3 (*g*	41. Kt to K6 (*j*)	B to Kt5 (ch)
19. B to B3	Kt takes P	42. K to K4	R takes Kt(ch)
20. B takes Kt	B takes B	43. K to Q3	P to Kt4 (*k*)
21. Kt to R3	Q to Kt 4	44. P to B4	B to Kt4
22. P to KKt3	B to K6	45. R to Kt2	R to K6 (ch)
23. Q to Kt2	Q to R3	46. Resigns (*l*)	

NOTES.

(*a*) Bird is very partial to this defence of the Ruy Lopez.

(*b*) Steinitz prefers Kt takes Kt followed by castling.

(*c*) Always risky capture at this early stage of the game.

(*d*) An attacking move.

(*e*) This is a tame move. P takes P would have been feasible.

(*f*) Zukertort suggested B to Q sq, with a view to playing B to B3 as a satisfactory answer to Black's very bold manœuvre with his QR

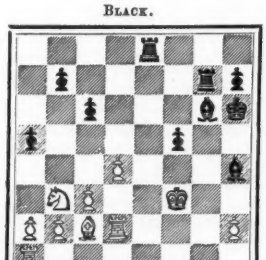
(*g*) Black plays in very fine attacking style, and carries all before him. White, being hard pressed, thought an exchange of Queens would relieve the strain.

(*h*) This is far-seeing play, the object being to play R to Kt sq.

(*i*) Cutting off the retreat of the King and threatening a speedy mate. We give a diagram of this interesting position.

Bird.

Black.



White.

Mackenzie.

(*j*) To prevent the mate by KR to B sq.

(*k*) To prevent an escape by K to B4.

(*l*) For if K to Q2, R to KKt6 (dis ch) and wins. Black's play in the latter part of the game has been very telling and ingenious.

ANSWERS TO CORRESPONDENTS.

*** *Please address Chess Editor.*

Chas. E. Bell.—The solution to 84 is quite correct; you seem to have moved R to B5 instead of B4.—Chief Editor.

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